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## THE USE OF THE TWO-CIRCLE CONTACT GONIOMETER IN TEACHING CRYSTALLOGRAPHY

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The two-circle contact goniometer was devised to supplement the two-circle reflecting goniometer, by furnishing a means for the measurement of medium-sized crystals not provided with sufficiently good reflecting faces for the successful use of the latter instrument. The contact goniometer has however proved itself adapted, in a greater degree even than the reflecting goniometer, to the demonstration of the principles of two-circle measurements, and their relation to geographic and astronomical measurements, and of the relations of normals to crystal faces and to projections, both stereographic and gnomonic. This simple and inexpensive instrument, a description of which is given on the following page, is thus fitted to serve a very important purpose in instructional work in crystallography.

With such laboratory directions as are given below, the student may be put to work on a natural crystal; and the definitions, axial characters, symmetry, forms, and symbols of the six systems are *discovered* by the student with little additional aid from the instructor. The making of a projection, determination of crystal constants, drawing of the crystal from the projection, and finally the cutting, from a gypsum cylinder, of an exact model of the crystal by the use of the Goldschmidt crystal modelling apparatus<sup>1</sup> give the student an intimate, complete, and ineffaceable knowledge of the crystal. This knowledge is won directly from the natural form; the time which might otherwise be spent in the study of wooden models is saved; there is no perplexing transition from perfect models

<sup>1</sup> V. Goldschmidt: Ueber einen Krystallmodellirapparat. *Z. Kryst. Min.*, 45, 573, 2 text figs., 1908.

to distorted and imperfectly developed natural crystals; and finally when one or two crystals from each of the six systems have been studied in this way, the student has received the preliminary training of an investigator in crystallography.

The crystal, when mounted on the holder *t* of the contact goniometer (fig. 4), may be conceived of as occupying the center of a sphere of which *H*, the graduated horizontal circle, is the equator; *V*, the vertical circle, is any meridian; and zero (0) on the vertical circle is the north pole. *S*, the steel rod, is a normal successively to any crystal face to which *p*, the plate borne on the rod, is made parallel.

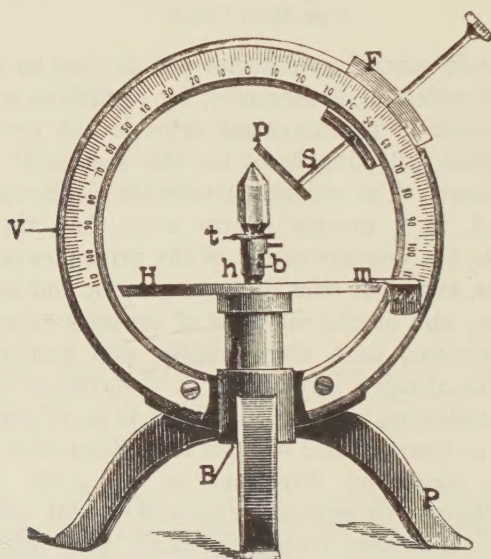


FIG. 4.

The position of this normal is fixed (1) by its longitude, *i.e.*, its distance measured on the equator from the zero meridian; (2) by its latitude, *i.e.*, the distance from the equator measured on a meridian. A like method is used to locate positions on the surface of the earth and to establish the positions of the heavenly bodies. In crystallographic determinations the first angular distance (longitude) is designated  $\varphi$  (*phi*); the complement of the second angular distance (latitude), *i.e.*, the distance from the pole (or zero) on the meridian is designated  $\rho$  (*rho*).

The position of the steel rod gives the position of a normal to



each crystal face in a sphere from which spherical and stereographic projections are made. If a sheet of paper or cardboard be placed tangent to the vertical circle at zero, the prolongation of the normals until they pierce this paper will give the points representing the faces on the gnomonic projection.

The symmetry of a crystal is revealed in the operation of measurement. For all crystals possessing more than one plane of symmetry, the horizontal circle is a plane of symmetry; and the vertical circle, on rotation of the crystal, becomes a plane of symmetry in two, three, or four positions. The symmetrical relations of prismatic, of pinacoidal, of domal, and of pyramidal faces are also successively disclosed on rotation of the horizontal circle.

A 20 centimeter spherical glass flask, ground, inverted, and fitted on a wooden pedestal, as devised by Professor Goldschmidt for use in his own laboratory, is serviceable in explaining to a class the method of locating crystal faces by angular measurements, ( $\varphi$  and  $\rho$ ), and in making clear the principles of projections.

#### LABORATORY DIRECTIONS FOR CRYSTAL MEASUREMENTS AND CRYSTAL PROJECTION.

1. Make several free-hand sketches of the crystal, one top view and from two to four side views, each roughly 3 cm. in diameter; with small crystals a reading glass should be used, magnifying the natural size three to five times.

2. Number carefully every crystal face in your sketches, first with pencil and, after verification, with pen and ink.

3. Prepare the following table in your laboratory notebook:

| No. | Symbol | Letter | Horizontal Reading | Vertical Reading | $\varphi$ | $\rho$ |
|-----|--------|--------|--------------------|------------------|-----------|--------|
|     |        |        |                    |                  |           |        |
|     |        |        |                    |                  |           |        |
|     |        |        |                    |                  |           |        |
|     |        |        |                    |                  |           |        |
|     |        |        |                    |                  |           |        |
|     |        |        |                    |                  |           |        |
|     |        |        |                    |                  |           |        |
|     |        |        |                    |                  |           |        |
|     |        |        |                    |                  |           |        |
|     |        |        |                    |                  |           |        |

4. Mount the crystal with heated wax,<sup>1</sup> in *vertical* position on the holder *t* (consisting of platform and rod).

5. Using key, fasten the holder in the center of the goniometer with dominant vertical faces of the crystal in alignment with the

<sup>1</sup> A mixture of beeswax and rosin, melted together in equal parts, is most satisfactory.

four holes, *b*, and by means of the ball and socket adjustment at *B* in figure (hidden by leg) using key in holes, carefully orient the crystal. The crystal is oriented when its prismatic faces read 90 degrees, or when the face normal to its polar axis reads zero, on the vertical circle.

6. Measure successively the *position angles* of the available crystal faces in (*a*) the prismatic zone, and (*b*) the pyramidal zone. These are the positions of normals to the crystal faces with reference to a horizontal (equatorial) plane and to a vertical (meridional) plane. White or black paper placed on the horizontal circle may add to the ease of reading. The plate carried on the steel rod should never be brought into actual contact with the crystal face, but the trace of the crystal face should be made parallel to the plate, which should be kept *exactly horizontal* for the readings on the horizontal circle, and *exactly parallel* to the plane of the vertical circle for the readings on that circle. The horizontal circle is graduated only to 5°, but can be read to 1° by means of the vernier at *m*. List your readings, horizontal and vertical, in table opposite the number of each face. Be very careful to identify the faces in your sketches, and to place the readings opposite the correctly identified faces.

7. Find the center of a sheet of drawing paper. From this center draw two circles with radii of 5 and 10 cm. respectively. Draw 0° (360°) and 90° meridional lines, and plot the *normal points*, that is, the positions of the normals established by the horizontal and vertical readings.<sup>1</sup>

8. When normal points are all plotted, draw *zonal lines*, making the necessary compensations to give equal distances (like units) in parallel directions.

9. Select two coördinates, one front and back, and the other right and left.

10. Determine the symbols (*p*, *q*) of the normal points, by means of their relations to these coördinates. The positions of the normal points of the most prominent pyramidal or domal planes are taken as the unit distances (*p*<sub>0</sub> and *q*<sub>0</sub>) on the coördinates. Note the *rationality of indices*. Insert the symbols in their proper places in the table.

<sup>1</sup> An explanation of the conversion of angular readings to linear distances for plotting, which appears at this point in the laboratory directions, is omitted here because it will be given in the next article in this series, on gnomonic projection.



11. Define the system to which the crystal belongs; (a) in terms of axes, (b) in terms of symmetry.

12. Determine the elements<sup>1</sup> of the crystal, graphically and by calculation: that is the values of  $p_0$ ,  $q_0$ ,  $r_0$ ;  $\lambda$ ,  $\mu$ ,  $\nu$  (polar elements);  $a$ ,  $b$ ;  $\alpha$ ,  $\beta$ ,  $\gamma$  (linear elements); and list them in upper left-hand corner of drawing paper.

13. Correct to the  $0^\circ$  meridian, and insert in the table the corrected values of  $\varphi$  and  $\rho$ .

14. Compare these values with those given in Goldschmidt's *Winkeltabellen* for the crystal under study, and insert in the table the proper letters.

15. Complete the projection by drawing a border parallel to the new  $0^\circ$  and  $90^\circ$  meridians, and place in this border the symbols of all the faces in the prismatic zone.

16. Make from the projection two drawings of crystal: top view and side view.<sup>2</sup>

#### NOTES

If it becomes necessary, in advanced work, to measure a crystal on which neither prismatic, basal, nor other pinacoidal planes are developed, the student must proceed in mounting the crystal as with the two-circle reflecting goniometer, bearing in mind that the roles of  $V$  and  $H$  are reversed.

The plotting of normal points may be accomplished rapidly and accurately by substituting for the tables of linear distances the Goldschmidt-Wright projection transporteur.<sup>3</sup> With large classes the tables (to be published in a subsequent article) are more practical.

<sup>1</sup> The numbers of variable elements (polar or linear), to be determined are:

|                        | $p_0$          | $q_0$    | $r_0$ |            |            |            | Planes<br>of Sym-<br>metry. | Lines of<br>Sym-<br>metry | Points<br>of Sym-<br>metry | Total |
|------------------------|----------------|----------|-------|------------|------------|------------|-----------------------------|---------------------------|----------------------------|-------|
| Isometric (0) . . . .  | 1              | 1        | 1     | $90^\circ$ | $90^\circ$ | $90^\circ$ | 9                           | 3                         | 1                          | 9     |
| Tetragonal (1) . . . . | $p_0 = q_0$    | $\infty$ | 1     | $90^\circ$ | $90^\circ$ | $90^\circ$ | 5                           | 4                         | 1                          | 5     |
| Hexagonal (1) . . . .  | $p_0 = q_0$    | $\infty$ | 1     | $90^\circ$ | $90^\circ$ | $60^\circ$ | 7                           | 6                         | 1                          | 7     |
| Orthorhombic (2) . .   | $p_0 > q_0$    |          | 1     | $90^\circ$ | $90^\circ$ | $90^\circ$ | 3                           | 2                         | 1                          | 3     |
| Monoclinic (3) . . .   | $p_0 \geq q_0$ |          | 1     | $90^\circ$ | $\mu$      | $90^\circ$ | 1                           | 1                         | 0                          | 1     |
| Triclinic (5) . . . .  | $p_0 > q_0$    |          | 1     | $\lambda$  | $\mu$      | $\nu$      | 0                           | 0                         | 0                          | 0     |

The number of variable elements (polar or linear) to be determined ranges for the six systems as above listed as follows: 0.1.1.2.3.5. Their number is thus a further clue to the system. The student may be assisted to define point of symmetry and line of symmetry in projections. The numbers of symmetrical lines for the six systems are respectively as follows: 8.4.6.2.1.0.

<sup>2</sup> Directions for crystal drawing will be given in a subsequent paper in this series.

<sup>3</sup> *Z. Kryst. Min.*, 45, 569-572, 190.

The projection figure restores the symmetry of the crystal, even tho it has apparently been completely lost in the natural crystal thru distortion in growth. It also indicates the position of the faces demanded by the symmetry, should some of them be missing on the natural crystal.

The relation of the Goldschmidt symbols, which are obtained very simply from the gnomonic projection, to Miller's symbols, to the Naumann and Weiss notation, and, in the hexagonal system, to the Bravais symbols, is readily understood; and the transformation of symbols is a desirable exercise.<sup>1</sup> By means of the gnomonic projection the reciprocals of the parameters—the indices—are directly obtained, and the student has no difficulty therefore in understanding why indices instead of parameters are used in the Goldschmidt and Miller symbols. The numerical values of  $hkl$  and of  $m$  and  $n$  are obtained from the projection.

The values of  $P_0$  and  $Q_0$  are obtained by measurement from the projection, and as  $R_0 = 5$  cm. in the projection, in order to make  $R_0 = \text{unity}$ , as required by the Goldschmidt symbols,  $P_0$  and  $Q_0$  are divided by 5. This is strictly true only in the isometric, tetragonal, hexagonal, and orthorhombic systems. In the monoclinic system one must first divide by 5, then multiply by sine  $\mu$ . In the triclinic system, one must divide by 5 and then multiply by cosine  $\rho$  of the basal plane.

In the monoclinic system there are the following determinations to make: Projection elements (I).  $H = 5$  cm.  $P_0', Q_0', R_0'$ , and  $E'$ . Divide I by 5 to obtain II. (II).  $h' = 1$ .  $p_0', q_0', r_0', e'$ , and  $h'$ . Multiply II by  $h$  (sine  $\mu$ ) to obtain III. (III).  $r_0 = h = 1$ .  $p_0, q_0, r_0, e, h, \lambda, \mu$ , and  $\nu$ . Given in *Winkeltabellen*. That  $p_0, q_0$ , and  $e$  are not the elements determined in the projection can be found by making a projection from the  $\varphi$  and  $\rho$  values in the *Winkeltabellen*, and then determining graphically the elements, which will be found to correspond to  $P_0', Q_0'$ , and  $e'$ .

In the triclinic system there are the following determinations to make: Projection elements (I).  $X_0', Y_0', P_0'$ , and  $Q_0'$ . Divide I by 5 to obtain II. (II).  $x_0', y_0', p_0'$ , and  $q_0'$ . Divide II by cosine  $\rho$  of basal plane to obtain III. (III).  $x_0, y_0, p_0$ , and  $q_0$ . Given in *Winkeltabellen*.

The utility of the two-circle contact goniometer, in combination with the gnomonic projection, is obvious. Its simplicity, its time-saving character, the readiness with which indices are found, and the ease of calculation and of crystal drawing, are all advantages which the crystallographer cannot fail to appreciate.

<sup>1</sup> With the use of pins and cork models of ground forms of each system the significance of symbols can be demonstrated, and an illuminating exercise in their use be given the student; see Goldschmidt "Ueber krystallographische Demonstration mit Hilfe von Korkmodellen mit farbigen Nadelstiften."



## STRICKLAND'S QUARRY, PORTLAND, CONNECTICUT

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Undoubtedly the best pegmatite locality at present being operated in Connecticut, from the standpoint of the mineralogist, is Strickland's quarry in Portland. This interesting quarry is easily accessible, being located on the west slope of Collins Hill, about 4 kilometers ( $2\frac{1}{2}$  miles) northeast of Portland Station. Collins Hill is indicated on the Middletown topographic sheet. The best way to reach the quarry is to go to Middletown, board a trolley car marked Portland, and ride to the end of the line, at Gildersleeve Post Office. From here to the quarry is a walk of 3 km. (a little less than two miles) due east, with no possibility of getting lost, as the dump of the quarry is visible from the car line.

The quarry, which is operated for feldspar, is a large open pit on a lens of coarse pegmatite included in a purplish muscovite-biotite schist. The main pegmatite vein reaches an extreme width of about 20 meters. Two narrower parallel dikes occur and one of these has been quarried, but the interesting minerals are found only in the largest or main vein. The pegmatite is composed almost entirely of buff microcline and smoky quartz, often in irregular, coarse intergrowth. Graphic granite is not abundant and where it occurs is too coarse to yield good hand specimens, except in occasional blocks. Some of the feldspar crystals are very large, a single mass of pure spar 6 meters in greatest diameter being visible on one wall of the quarry. Muscovite, which is not abundant, occurs in plates up to 15 centimeters in diameter, nearly all of which show the twinning structure known as feathering. Biotite is not visible on the walls but is abundant in some parts of the dump in broad plates up to 6 decimeters in length by 3 decimeters in breadth and only about 1 cm. in thickness.

Beryl occurs in the solid pegmatite in dull but well bounded and doubly terminated crystals of a pale green color. Most of them are a decimeter or more long, and they make excellent cabinet material. Mr. Strickland has in his possession a single pink beryl and he reports having found a shattered transparent beryl of pale aquamarine color which cut a number of small

gems. Black tourmaline is widely distributed in the pegmatite and occasional good specimens can be secured, but the crystals are for the most part badly shattered. Uraninite has been found in beautifully sharp octahedral crystals. These have been carefully preserved and thirty-five specimens were disposed of to Wesleyan University. The uraninite is distributed in a plane parallel to and about a meter from one wall. Columbite occurs distributed sparsely and in well-defined crystals up to 3 cm. in diameter, also near the walls of the deposit. In the part of the quarry now being opened spodumene occurs in crystals up to 3 dm. in length, showing well defined cleavage. The material is mostly perfectly fresh with pearly luster and white to pale lilac in color. Other specimens are altered to a woody, fibrous substance like anthophyllite in appearance. The spodumene resembles typical Branchville material but apparently does not alter to the cymatolite aggregates here. Apatite occurs in well-defined small crystals of a gray to pinkish color.

The pegmatite is drilled by steam drills and blasted, the quarry being worked in steps. In the first 10 meter slice below the surface numerous pockets were found containing many beautiful tourmalines. In the next great slice 12 m. in vertical height and the whole length of the deposit, no tourmalines of any consequence were found, the pockets being filled with coarse quartz crystals. At the present time a third horizontal section is being cut and the part of the pit being worked is literally honeycombed with pockets. The largest pocket seen was in the floor of the quarry and was not well exposed, being merely a soft rusty spot in the ledge some two meters across, ribbed with veins of clevelandite between which were cellular sponges of iron-stained secondary albite cementing numerous transparent to translucent tourmalines. Apparently the tourmalines were badly broken and the parts separated before the cementing materials were deposited so that now the specimens are tourmaline breccias. The tourmalines are in large part perfectly transparent and most of them are green in color. Others are blue or blue gray to almost colorless and a few are typical "water-melons" with a green exterior and a purplish pink core. The prism faces are smooth and lustrous but the crystals are almost always broken at both ends, pieces 1 cm. in diameter and 3 cm. in length being the rule. Much larger crystals occur however. The writer picked up one mass weighing approximately three



kilograms and completely encrusted with the brown secondary crust. When split this mass was found to be a single crystal aggregate of tourmaline, purplish at the base, rubellite pink in the central portion and green in the upper third. Mr. Strickland concluded that he wanted this specimen, and it has since been purchased by Prof. Ford for the Brush collection. Another crystal found by the writer was 18 cm. long and 5 cm. in diameter, and broken in the middle. The lower half, which contained some gem material, was held at the quarry but the upper portion was retained by the writer. Another rough crystal 4 cm. by 5 cm., is pale green with an opaque pink core, and a third portion of a crystal 2 cm. in diameter is transparent and aquamarine blue with deep blue spots. A considerable amount of the cellular material from the pocket was collected and will be carefully examined for herderite and other rare minerals.

In the vicinity of the pockets the bladed variety of albite known as clevelandite occurs in great abundance in plates of a bluish white color ranging from several cm. broad down to aggregates so fine-grained that the individual plates are scarcely distinguishable. Opaque to translucent green tourmaline occurs near the pockets in aggregates of prisms which make handsome specimens. Here the crystals of muscovite are penetrated by bladed crystals of green tourmaline and bordered by a narrow band of pale pink lepidolite in parallel position. Lepidolite also occurs in considerable masses of fine scales of a beautiful deep purple color intergrown with quartz and clevelandite and in aggregates of coarser scales of a gray color. In the pocket zone crystals of black tourmaline are often bordered with opaque green, and opaque green tourmaline also occurs in intergrowth with large masses of brownish red garnet. Many of the pockets are lined with large quartz crystals which are rough and opaque in the exterior portion but are beautifully transparent and of a smoky to citrine yellow within. The rhodonite recently described by Professor Foye<sup>1</sup> was from this quarry. Specimens said to be the same as those obtained by Professor Foye examined by the writer proved to be a slightly manganiferous orthoclase of deep reddish brown color.

Mr. Strickland, who owns and operates the quarry, will extend courteous treatment to collectors who do not make too much

<sup>1</sup> *Am. Min.*, 4 (10), 124, 1919. A complete list of the minerals which have been found in the vicinity is included in this paper.

of a nuisance of themselves. It is best to meet him frankly and agree to allow him to examine what one has collected before leaving the quarry, and he will permit one to retain practically everything but gem material. The gems are preserved and cut and marketed irregularly. Especially good specimens of rare minerals are laid aside and sold to visiting collectors and students, at reasonable prices, it being necessary for the owner to take advantage of every source of revenue, at present cost of labor and materials, in order to keep an industry of this sort going. It is not necessary to buy any specimens, however, in order to bring away all one can carry of exceptionally fine mineralogical material. The quarry is better collecting ground now, perhaps, than it has ever been in the past and gives promise of improving as the work progresses.

### COLLECTING MINERALS IN CUMBERLAND, ENGLAND

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One of the most ideal districts for the mineral collector is the county of Cumberland, in the northwest corner of England. Let me guide you on a two weeks excursion to the old and new mines.

Taking a train from the old cathedral town of Durham up the Wear Valley, known to every collector for its fluorites, we cross the Kilhope to Nenthead. There was formerly a large plant located there for mining galenite. This mineral had considerable sphalerite associated with it, and at that time no commercial method of treating it was known, so it was thrown on the dumps. Very fine specimens of sphalerite are found there, besides galenite crystals which have been washed out from beneath, leaving a thin crust coated on the inside with corroded galenite on which small crystals of sulfur are sometimes found. Fluorite is also found there, but not in the highly developed crystals which occur on the other side of the hill, in Weardale, county of Durham. A very interesting variety of fluorite consists of fairly clear and colorless crystals containing a band of azure blue and then a green, these colors being formerly attributed to copper.

A few miles down the Nent valley are the barite mines of



Nentbury, where are found fine obtuse crystals of witherite, some of which are incrustated with barite. In addition there are to be found, rarely, radiating hexagonal prisms terminated by the basal pinacoid, of witherite pseudomorph after aragonite. Following the road further down the valley on the right hand side we come to dumps of former lead mines. These are the famous Bromley Hill mines where the bromlite variety of alstonite was first found. Later better specimens came from Fallowfield near Hexam in Northumberland. A little further down the valley we come to more dumps and below these a few small heaps of rock in which have been found barytocalcite in well developed yellowish and water white crystals.

The next place on the trip is Alston, formerly a famous mining town, but unfortunately no mines worth visiting are left except in some of the adjacent valleys, where a fair amount of lead and zinc is still mined. Occasionally one finds some good stalactites, also satinspar, and dolomite in fine druses. In Alston there is a limestone quarry where are to be found fairly good druses of aragonite; and fine druses of cuboid calcite from the lead mines, which have found their resting place in nearly all the museums of Great Britain. From Alston we go westward to the Dufton and Appleby mines. At Appleby are found good druses of clear yellow fluorite, and Dufton is the locality where the finest specimens of colorless clear tabular barite are obtained. A few miles north is Little Salkeld, with its gypsum mine. There we can get fine plates of selenite, also colorless, yellow and flesh red fibrous gypsum.

Returning to Appleby we take the train to Penrith and then to Keswick from which point we can continue our excursion to all parts of West Cumberland. The mines near Keswick have long since been worked out, with the exception of the Threlkeld lead and zinc mines. The Thornthwaite mines, near Bessenthwaite Lake, do not offer much to the collector except chrysotile. The real paradise for the collector is north and northeast of the Skiddaw. Those old mines are best reached from Caldbeck, of which the old rhyme says, "Caldbeck and Caldbeck fells are worth all England else."

From Caldbeck we first reach the old dumps of the Redgill mine, then the Silvergill mine and further along the Roughton-gill mine, all of which were worked long before the invasion of England by the Romans, and are within a short distance of each

other. Here are to be found malachite, brochantite, olivenite, melaconite, chrysocolla, aurichalcite, chalcocite, chalcopyrite and calamine; and of the lead minerals, galenite, cerussite (white and green), minium, anglesite, leadhillite, caledonite, linarite, pyromorphite and mimetite. The pyromorphite crystals are sometimes found on plumbogummite, and are often changed to that mineral. The Drygill mine, situated in the upper part of the valley, is an old lead mine worked at one time for campylite, which commanded a good price for glass making. The small amount of psilomelane found with the campylite probably made it especially desirable for this purpose. Small druses of an orange to nearly red color can still be found on the dumps. Some of the barrel-shaped crystals are changed into psilomelane, and the deepest colored crystals are always in lumps of earthy psilomelane.

Going up to the top of the "gill" and southeast over the fells the only living things one meets are moorhens (grouse) or, in the distance on the side of the fells, perhaps some sheep. It is to be hoped you do not get caught in a rain storm, as happened to me the last time I was there. One can not see ten meters away. An umbrella is of no use, as it rains from above, from below, and from all sides. Ten minutes are sufficient to give you a soaking, even in a rain-coat. Road or path there is none, only sheep paths and those lead in all directions except the right one. In good weather it takes about three quarters of an hour to cross the fell and go down the Brandygill to the Carrock mines. These mines were formerly worked for lead, and only about fifteen years ago was the value of the tungsten ores found there recognized. Here are found fine specimens of wolframite, wolframite pseudomorphs after scheelite, bismuth in small grains (often covered with a fine coating of gold), scheelite, molybdate, ilmenite, wulfenite, bismite, bismuthinite, stolzite, arsenopyrite, "gruenlingite," pyrrhotite, pyrolusite, and marmatite. The scheelite from Carrock contains radium. Of non-metallic minerals found there may be mentioned corundum, diallage, fibrous tourmaline, apatite and muscovite variety gillbertite, also large crystals of quartz sometimes over a half meter long.

We leave the Carrock mines and take a "trap" for Troutbeck station. Near the station were found two lumps of antimonite, in excavating for the railroad, but none have since been found



nor has the source been discovered. At Troutbeck we take the train back to Keswick, and going southwest near the Causey Pike a mine is passed from which smaltite and erythrite have been obtained. On the west of the Skiddaw is a vein of barite and further along are found chialtolite, and, in the igneous rocks about Derwentwater Lake, apatite, beryl, jasper, carnelian chlorite, enstatite, epidote, garnet, labradorite, olivine, oligoclase, orthoclase, serpentine and talc.

Lastly we come to the west coast of Cumberland. In the north are the coal mines of Maryport and Whitehaven, and south and east of Whitehaven are the Cleatormoor iron mines where are found the hematite kidney ore and specular iron. Also, over the whole distance from Frizington to Egremont, the beautiful calcite crystals. This is also the district where the well-known colorless, green, yellow and brown barite crystals come from. Very often the hematite is covered with fine crystals of smoky quartz and thin hexagonal plates of specular iron which sometimes are over a centimeter in diameter. Altogether about one hundred and ten different mineral species are to be found in the county of Cumberland.

## ETCHING IRON METEORITES

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Recent experiences of the writer have led him to adopt some modifications in the method of etching iron meteorites which was originally furnished him by Foote Mineral Company, and quoted in this magazine.<sup>1</sup>

The principal change in this method which the writer's experience has indicated as desirable is the use of a large magnet for holding the meteorite section during etching. Magnets of a size capable of sustaining the weight of any ordinary section can be obtained from many dealers in physical apparatus. That which the writer uses is able to sustain a weight of 12½ kilograms. Holding the section with such a magnet, the polished surface which it is desired to etch can be dipped into the etching fluid without the necessity of exposing the entire section to the action of the fluid. Lacquering of the back of the section is thus made unnecessary. The building up a wall of wax or clay about the border of the section to contain the etching fluid,

<sup>1</sup> *Am. Min.*, 2, 39, 1917.

as has often been done, is also avoided. This latter practice is especially objectionable because it leaves an unetched border which is invariably taken by the general public to represent a crust formed on the meteorite by atmospheric heating. The excess of fluid can also be more readily and thoroly removed after such a dipping than if the section were all exposed to its action. Moreover, pouring of the fluid (usually acid) on the section, after the common method, causes the fluid to penetrate deeply into cracks and pores where traces of it are pretty sure to remain and cause subsequent decomposition.

A second modification of the previously published method consists, if an acid etching fluid has been used, in immersing the section in lime water after etching and washing. This is for the purpose of neutralizing any traces of acid that washing might not have removed. The more elaborate methods which have been recommended by some authors for removing such traces of the etching fluids, such as washing with ammonium carbonate, water, alcohol and ether in succession, the writer has not found in practice to be necessary.

The method of etching at present recommended by the writer is, then, as follows:

1. Provide two photographer's trays of glass, porcelain or other acid-resisting substance of a sufficient size to receive the section to be etched. Partially fill one tray with a 10 per cent. solution of C. P. nitric acid, the other with lime water. Provide also a small bottle of "steel gloss"<sup>1</sup> preferably diluted about one-half with benzine, one small camel's hair brush, one large camel's hair brush, a good sponge and several dry cloths.

2. Wash the surface of the section that is to be etched thoroly with benzine, for the purpose of removing all traces of grease or oil from it.

3. Lacquer with "steel gloss" any nodules of accessory minerals. They should be completely covered, so that they cannot be reached by the etching fluid, or they will stain the etched surface. On the other hand, the lacquer should not extend any farther over the border of the nodule than is necessary for its protection, as any portion of the section covered by the lacquer will not be etched.

<sup>1</sup> "Steel gloss" can be obtained of E. F. Houghton and Company, Philadelphia and other large cities. This firm specializes in rust-preventing liquids and their "steel gloss" is the most efficient protection for meteorites that the writer has found.



4. After the protective lacquer has dried sufficiently, which will be in a few minutes, especially if the drying is assisted by a little heat, take up the section by means of the magnet, with the surface to be etched outward. Holding the section with the magnet, immerse the section in the etching fluid to a depth not greater than is necessary to cover the entire surface to be etched, and accompany the immersion with a slight rocking motion in order to release bubbles of air that usually form on the immersed surface and interfere with the etching. At intervals of a few seconds, turn up the etching surface for examination, occasionally washing or rubbing off the surface in order to observe the progress of the etching. Usually in less than two minutes the etching figures will be seen to have reached their maximum brilliancy, and the etching should be discontinued. If etched too long, the iron will darken.

5. Sponge and wash thoroly the etched surface and immerse the section for a few seconds in the lime water previously provided.

6. Again wash the section and dry it as thoroly as possible with the dry cloths.

7. Lacquer the etched surface, and give the section a final thoro drying by gentle heat.

## PROCEEDINGS OF SOCIETIES

### THE PHILADELPHIA MINERALOGICAL SOCIETY

*Wagner Free Institute of Science, January 8, 1920*

A stated meeting of The Philadelphia Mineralogical Society was held on the above date with the president, Dr. Burgin, in the chair. Sixteen members and four visitors were present. Dr. Alfred C. Hawkins, Wilmington, Delaware, was elected to active membership.

Dr. Hawkins addressed the society on "Mineralogical Experiences" at a number of localities in Rhode Island, New York, New Jersey, Oklahoma Texas and Missouri, illustrated with lantern slides and specimens.

Mr. Trudell announced the formation of The Mineralogical Society of America, and the taking over of THE AMERICAN MINERALOGIST by the new society.

SAMUEL G. GORDON, *Secretary*.

### NEW YORK MINERALOGICAL CLUB

*January 14, 1920*

The Regular Monthly Meeting of the New York Mineralogical Club was held in the American Museum of Natural History on the evening of Wednesday, January 14, at 8.15 P.M. The President, Dr. George F. Kunz, presided and there was an attendance of 28 members. Mr. William Maurer, of 630 84th St., Brooklyn, was elected to membership.

The discussion for the meeting, Quartz and mineral inclusions in quartz, was then introduced by the Chair, who called upon members to show specimens of interest illustrating this topic. Mr. Ashby exhibited specimens of capped quartz from a number of localities including one with 4 caps, one of them removable, from Schlaggenwald, Bohemia; specimens illustrating Babel quartz and unusual terminations, as well as some examples of inclusions.

Capt. Miller discussed the physical properties of quartz, dwelling particularly on the origin of the colored varieties, blue, violet and pink quartz and cited recent authorities to the effect that some of these colors are due to small percentages of manganese oxide. He also discussed pyro-electric phenomena, etching-figures, and the effects obtained by ultra-violet light.

Mr. Whitlock exhibited a diagram explaining the twinning laws of quartz, and models illustrating right and left crystals and twinning habits. He also showed characteristic examples of twinned intergrowths, parallel position intergrowths with a marked tendency toward skeleton crystals, and a remarkable example of multiple phantoms.

Mr. Wintringham explained by means of blackboard diagrams right and left handed crystals of quartz, and showed a curiously distorted crystal. Mr. Manchester spoke of quartz including pyrrhotite crystals from King's Bridge. Dr. Kunz exhibited a particularly fine quartz phantom from Madagascar, and discussed quartz inclusions. Miss Luther showed a handsome suite of cut quartz illustrating the applications to jewelry.

HERBERT P. WHITLOCK, *Recording Secretary*

## NOTES AND NEWS

Dr. Waldemar T. Schaller has resigned from the U. S. Geological Survey and Mr. Harry F. Gardner from the New York State Museum, both to enter industrial work.

## ABSTRACTS—CRYSTALLOGRAPHY

THE ARRANGEMENT OF ELECTRONS IN ATOMS AND MOLECULES. IRVING LANGMUIR. *Gen. Elec. Co. J. Am. Chem. Soc.*, **41** (6), 868-934, 1919.

Chemical evidence indicates that the electrons in the atom (at least the outermost ones) are essentially stationary. In some simple atoms, such as those of the inert gases, the electrons are arranged in pairs symmetrically placed about the equatorial plane, so that the symmetry is holohedral tetragonal. By considering the properties and behaviors of atoms of various elements, it is possible to work out probable electron arrangements for a number of them. The tendency for electrons to form groups of 8, or octets, is marked, and the valence of many elements can be accounted for in this way. The constitution of organic, simple inorganic, and complex inorganic compounds can be worked out on this basis. [The original contains a vast amount of additional data.]

E.T.W.

ISOMORPHISM, ISOSTERISM, AND COVALENCE. IRVING LANGMUIR. *J. Am. Chem. Soc.*, **41** (10), 1543-1559, 1919.

That the valence of the chemical elements is related to the electrons in their atoms has been demonstrated by many recent investigations; and



Langmuir has elaborated an "octet theory of valence," according to which the atoms are bound together by pairs of electrons held in common, arranged in definite positions in the atoms. [See preceding abstract.] He proposes the term *covalence* for the number of electron pairs and *isosteric* to describe molecules in which the number and arrangement of the electrons are alike.

The conception isomorphism has been applied by different authors in a variety of ways. In the strictest sense it is limited to substances closely related in both chemical composition and crystal form. The magnesite (or calcite) group of minerals is a typical example of strict isomorphism; the crystal class is trigonal-rhombohedral (scalenohedral) with the axial ratios ranging from 1:0.80 to 1:0.85, the compounds included being  $\text{MgCO}_3$ ,  $\text{CaCO}_3$ ,  $\text{MnCO}_3$ ,  $\text{FeCO}_3$ ,  $\text{CoCO}_3$  and  $\text{ZnCO}_3$ . It has long been known that sodium nitrate,  $\text{NaNO}_3$ , is closely related in form to the magnesite group, its class being the same, its axial ratio 1:0.83; and, when it is allowed to crystallize on a cleavage surface, it forms parallel growths with the mineral. Nevertheless many crystallographers have denied that sodium nitrate is isomorphous with magnesite, calcite, etc., since according to the usual valence theory, their chemical structures are unlike, being respectively:



But Langmuir finds that on the basis of his theory sodium is isosteric with magnesium and the nitrate ion is isosteric with the carbonate ion, the structures of the compounds being if the abstract or interprets this correctly:



Sodium nitrate is accordingly isomorphous with magnesite not only as to crystal form but also as to chemical structure.

Other similar cases, where the crystal forms of compounds are alike, but their structures, according to the usual interpretations, are not, can be readily explained by the octet theory. In addition to many instances among artificial compounds, Langmuir points out two among minerals, the tetragonal group including cassiterite,  $\text{Sn}_2\text{O}_4$ , zircon,  $\text{ZrSiO}_4$ , and xenotime,  $\text{YPO}_4$ ; and the triclinic plagioclase feldspars, albite,  $\text{NaAlSi}_3\text{O}_8$  and anorthite,  $\text{CaAl}_2\text{Si}_2\text{O}_8$ . [The abstractor can not refrain from calling attention to several additional cases, in which similarity in crystal form has been pointed out by crystallographers, although true isomorphism might well be questioned by chemists because of unlike structures; isosterism probably exists in these cases:

Fluorite,  $\text{CaF}_2$ , is isomorphous with yttriofluorite,  $\text{YF}_3$ , (though not with sellaite,  $\text{MgF}_2$ ); fergusonite,  $\text{YCbO}_4$ , is isomorphous with scheelite,  $\text{CaWO}_4$ , etc.; danburite,  $\text{CaO.B}_2\text{O}_3.2\text{SiO}_2$  is isomorphous with andalusite,  $2\text{Al}_2\text{O}_3.2\text{SiO}_2$ ; in the rutile group,  $\text{Ti}_2\text{O}_4$  is isomorphous with tapiolite,  $\text{FeTa}_2\text{O}_6$  and other similar compounds. Indeed, titanates seem to be isomorphous with columbates in many rare-earth minerals; and finally, in the alunite-beudantite group, sulfates are isomorphous with phosphates and arsenates in a striking way, and recognition of this has made possible the establishment of the correct formulas of some very complex minerals.] E.T.W.

THE NATURE OF THE FORCES BETWEEN ATOMS IN SOLIDS.  
RALPH W. G. WYCKOFF. Geophysical Lab. *J. Wash. Acad. Sci.*, 9 (19), 565-592, 1919.

It seems possible to arrange all crystalline solids in a number of groups according to the nature of the forces between their atoms. All recent studies of atoms have indicated that they are built up of electrons; and there is evidence that the outer electrons tend to form clusters of 8, occupying the positions of the corners of a cube. The phenomenon known as valence is explainable in many cases as the result of this tendency. [See preceding abstracts.] All chemical compounds may be considered as included within the following extremes, having the atoms electrically: (1) charged; and (2), neutral. In case 1, the compound is called polar, in case 2, non-polar. In the former the outside electrons of the electropositive atom are drawn toward the electronegative one, to form a cluster of 8. In the latter there is no transfer of electrons, but the fields of electrical force of the atoms interact. Each unit of valence represents two electron bonds. All gradations between these extremes probably occur.

In non-polar compounds, of which organic compounds are typical examples, the electrons are rather firmly united to the atoms, and the molecules are well-defined, in solid and liquid as well as gaseous states. In polar compounds, however, of which sodium chloride may be taken as an example, electrons go over from one atom to another. A crystal of such a substance consists of a group of electrically charged atoms, or ions, held together mainly by the electrostatic forces of attraction between positive and negative charges. The "molecule" disappears completely in the solid, being present only in the gaseous state. Bragg's X-ray studies led to the above structure of the sodium chloride crystal. In sodium nitrate, calcium carbonate, etc., the nitrate and the carbonate ions act as single units. Three factors are of importance in determining the crystal form of such substances: (1) The stable arrangement of points in space which correspond in number and in charge with the ions of the substance. (2) The number and arrangement of the atoms making up these ions. (3) The volumes of the ions. The NaCl grouping is the simplest possible for an equal number of positive and negative ions of about equal volume.  $\text{NaNO}_3$  and  $\text{CaCO}_3$  are essentially the same, with the  $\text{NO}_3$  and  $\text{CO}_3$  ions instead of Cl.

There is also another type of compound, which may be called the valency compound, of which diamond, magnetite, carborundum, many oxides, sulfides, etc., are examples. No electron transfer takes place, and each valence unit corresponds to two electron bonds. The atoms are held together by valency but the chemical molecule does not appear, the entire crystal being a single chemical individual. Three limiting types of crystalline solids thus exist: (1) Molecule-forming compounds; (2) polar compounds, and (3) valency compounds. Combinations and transitions between these are frequent; thus in  $\text{NaNO}_3$  the Na and the  $\text{NO}_3$  ion are mutually polar, but the atoms in the latter are held together by valence. Silver halides are midway between 1 and 2, in that the electrons lie midway between the atoms. (For many details see original.)

E.T.W.

## THE BUILDING OF ATOMS AND THE NEW PERIODIC SYSTEM.

WILLIAM D. HARKINS. University Chicago. *Science*, **50**, 577-582, Dec. 26, 1919.

The arrangement of the elements usually known as the Mendeléef periodic system is now recognized to express the arrangement of the outer electrons in the various kinds of atoms. Professor Harkins has developed a new periodic system (the periods being two atoms in length, instead of 2, 8, 18, and 32), connected with the structures of the nuclei of the atoms. It is based on the atomic numbers of the elements, the atoms of those of even atomic number being built up of helium nuclei alone, while odd ones contain hydrogen nuclei in addition. The even-numbered atoms should be, theoretically, much more stable than the odd ones. This can best be tested out by studies of the occurrence of the elements in nature; and it has been fully confirmed, as shown by these data: In iron meteorites the even numbered atoms are 127 times more abundant than the odd ones; in stone meteorites 47 times more abundant. In the earth's crust the even numbered atoms are 10 times more abundant than the odd ones. All of the seven most abundant elements in meteorites are even numbered, and these 7 make up 98.6% of the material of meteorites. The most stable nuclei seem to be those of oxygen, magnesium, silicon, and iron, all even numbered elements of low atomic number. (Additional details as to the inferred atomic structures, etc., are given in the original.) E.T.W.

THE ABSOLUTE CALCULATION OF CRYSTAL PROPERTIES WITH THE AID OF THE BOHR ATOMIC MODEL. M. BORN AND A. LANDÉ. *Sitzb. preuss. Akad.*, **1918**, 1048-1068.

CRYSTAL SPACE-LATTICES AND THE BOHR ATOMIC MODEL. M. BORN AND A. LANDÉ. *Ber. physik. Ges.*, **20**, 202-209, 1918.

THE CALCULATION OF THE COMPRESSIBILITY OF CUBIC CRYSTALS FROM THE SPACE LATTICE THEORY. M. BORN AND A. LANDÉ. *Ber. physik. Ges.*, **20**, 210-216, 1918.

THE ELECTROSTATIC POTENTIAL OF THE FLUORITE LATTICE. A. LANDÉ. *Ber. physik. Ges.*, **20**, 217-223, 1918.

THE CALCULATION OF ABSOLUTE CRYSTAL DIMENSIONS. M. BORN. *Ber. physik. Ges.*, **20**, 224-229, 1918.

FOUNDATIONS OF THE OPTICS OF CRYSTALS. III. THE CRYSTAL OPTICS OF X-RAYS. P. P. EWALD. *Ann. Physik.*, **54**, 519-546, 557-595, 1918.

ROENTGEN-RAY INTERFERENCE AND MIXED CRYSTALS. M. VON LAUE. *Ann. Physik.*, **56**, 497-506, 1918.

DETERMINATION OF THE CRYSTAL STRUCTURE OF COMPLEX COMPOUNDS. P. NIGGLI. *Physik. Z.*, **19**, 225-234, 1918.

Abstracts of the above series of 8 mathematical and theoretical papers will be found in *Chem. Abstr.*, **13** (14), 1556-1558, 1919. E.T.W.



ARTIFICIAL GLIDING AND TRANSLATIONS IN MINERALS, ACCORDING TO THE STUDIES OF K. VEIT. A. JOHNSEN. Kiel. *Centr. Min. Geol.*, 1918, 265-266.

When the minerals were embedded in sulfur and exposed to high pressures, translations were obtained with fluorite, sphalerite, rhodochrosite, smithsonite, barite, anhydrite, and aragonite; gliding was shown by hematite, corundum, and anhydrite. E.T.W.

TOURMALINE FROM THE BROCKEN GRANITE AT SCHIERKE, HARZ. KARL SCHULZ. Berlin. *Centr. Min. Geol.*, 1918, 266-268.

A description, with figures, of two small crystals is given. They are well developed and show marked hemimorphism, but no rare or new forms. E.T.W.

CRYSTALS OF QUARTZ FROM MONTE CALANNA, ETNA. SALVATORE DI FRANCO. *Atti accad. Lincei*, 27, I, 203-208, 1918.

An ancient lava of Etna found on this mountain is interesting in containing a number of crystallized minerals; a petrographic description of the rock is given. In geodes in the lava occur quartz crystals up to 7 mm. long, showing now and then unusual development. The forms observed were:

$r$  (10 $\bar{1}$ 1),  $M$  (30 $\bar{3}$ 1),  $f$  (40 $\bar{4}$ 1);  $z$  (10 $\bar{1}$ 1),  $\pi$  (10 $\bar{1}$ 2);  $m$  (10 $\bar{1}$ 0);  $s$  (11 $\bar{2}$ 1);  $x$  (51 $\bar{6}$ 1) and  $y$  (41 $\bar{5}$ 1). There are also rough faces in the basal position, (0001). Details of combinations and of measurements by which these forms were established are given. E.T.W.

MANGANOUS TARTRATE AND POTASSIUM MANGANOUS TARTRATE. LEONARD DOBBIN; crystallography by MARY W. PORTER. *J. Am. Chem. Soc.*, 41 (6), 934-940, 1919.

The method of preparation of manganous tartrate is described. Its crystals are monoclinic, with a prism, base, and side-dome, axial ratios  $a:b:c = 0.816:1:0.699$ , angle  $\beta = 100^\circ 14'$ . The faces are curved and striated, making measurements only approximate. The angle table is given in the following form:

| Face    | Azimuth ( $\varphi$ ) |            | Polar Distance ( $\rho$ ) |            |
|---------|-----------------------|------------|---------------------------|------------|
|         | Observed              | Calculated | Observed                  | Calculated |
| $m$ 110 | *51° 13'              | —          | 90° 00'                   | 90° 00'    |
| $c$ 001 | 87 23                 | 90° 00'    | 11 15                     | 10 14      |
| $q$ 011 | *14 28                | —          | *35 50                    | —          |

[The placing of observed and calculated values of each angular coordinate side by side emphasizes the degree of accuracy attained; although it is usually preferable to group all observations together. Abstr.] E.T.W.

CRYSTALS WITH OPTICAL ROTATORY POWER. T. LIEBISCH. *Sitzb. preuss. Akad.*, 1918, 821-839.

The phenomena obtained by superposing plates of optically active crystals are discussed mathematically, and some fine photographs of the effects obtained with right and left handed quartz are given. E.T.W.

## ABSTRACTS—MINERALOGY

THE LIMITS OF MIX-CRYSTAL FORMATION BETWEEN POTASSIUM CHLORIDE AND SODIUM CHLORIDE. R. NACKEN. Tübingen. *Sitzb. preuss. Akad.*, 1918, 192-200.

There being some uncertainty as to the exact relation between these salts, a new series of observations was made, using the determination of the refractive index by the immersion method for obtaining the composition of the mixtures. The concentration-temperature diagram was found to show a maximum at slightly less than 500° and 65 molecular per cent. NaCl.

E.T.W.

THE TELLURIDES OF BISMUTH. M. AMADORI. *Gazz. chim. ital.*, 48, II, 42-53, 1918; *Atti accad. Lincei*, 27, I, 131-133, 1918.

Fusions of  $\text{Bi}_2\text{S}_3$  with  $\text{Bi}_2\text{Te}_3$  have been studied, but only one compound was found, containing equal molecular amounts of these. No substances corresponding to the minerals tetradyomite, "joseite," "grünlingite," etc., were obtained.

E.T.W.

THE COMPOUNDS OF THE FLUORIDE AND THE CHLORIDE WITH THE PHOSPHATE OF LEAD. M. AMADORI. *Atti accad. Lincei*, 27, I, 143-148, 1918.

Fusions yielding pyromorphite and the corresponding fluo-pyromorphite, not known in nature, have been studied. Detailed thermal data are given.

E.T.W.

ANHYDROUS PHOSPHATES, ARSENATES, AND VANADATES OF LEAD. M. AMADORI. *Atti ist. Veneto*, 76, 419-433, 1917; thru *Chem. Abstr.*, 13 (14), 1568, 1919.

A description of thermal studies of the systems  $\text{PbO-P}_2\text{O}_5$ ,  $\text{PbO-As}_2\text{O}_5$  and  $\text{PbO-V}_2\text{O}_5$ . Several compounds were found to exist in each system.

E.T.W.

ALLOYS OF IRON AND NICKEL DEPOSITED ELECTROLYTICALLY. P. BENVENUTI. *Atti ist. Veneto*, 76, 453-477, 1916; thru *Chem. Abstr.* 13 (15), 1675, 1919.

In the course of the chemical studies alloys corresponding to the meteoritic varieties taenite and kamacite were obtained.

E.T.W.

THE PRESENCE OF BORON IN CERTAIN NATURAL BASIC SILICO-ALUMINATES. A. LACROIX AND A. DE GRAMONT. *Compt. rend.*, 168, 857-861, 1919.

Spectroscopic examination having shown the presence of boron in Madagascar occurrences of several basic aluminosilicate minerals in which it has not been heretofore recognized, analyses were made by Dr. Raoult, giving: sapphirine, 0.75, grandidiérite 2.81 and kornérupine, 3.59, per cent. of  $\text{B}_2\text{O}_3$ . It is suggested that the B occurs as an isomorphous replacement of aluminium and ferric iron. B was also found in variable amounts in dumortierite and vesuvianite.

E.T.W.

MINERALS FROM RHODESIA. IMPERIAL INSTITUTE. *Bull. Imp. Inst.*, 16 (4), 456-476, 1918.



While this paper is chiefly devoted to statistics of production and occurrence of various ores, it includes also a report of the discovery of a sand composed largely of what appeared to be the rare mineral microlite, [identity not adequately established, however. Abstr.] analysis of which gave:  $Ta_2O_5$  63.41,  $Cb_2O_5$  16.80,  $Fe_2O_3 + FeO$  0.27,  $U_3O_8$  0.10,  $TiO_2$ ,  $As_2O_3$  none,  $MnO$ ,  $SnO_2$  trace,  $Ce_2O_3$  0.50,  $CaO$  12.75,  $MgO$  0.70,  $K_2O$  0.50,  $Na_2O$  3.52,  $SO_2$  0.06,  $SiO_2$  0.50, ign. 0.50, sum 99.61 per cent. [Unfortunately fluorine was not determined; the analysis leads approximately to the formula  $2CaO.Ta_2O_5$ , theory  $CaO$  12.8,  $Ta_2O_5$  87.2%, but there is an excess of bases. Abstr.]

E.T.W.

A HYDROMAGNOCALCITE FROM THE LOPUSNA VALLEY NEAR LUCSIVNA, SOUTHERN TATRA MOUNTAINS. EMANUEL GLATZEL. *Centr. Min. Geol.*, 1918, 307-311.

The composition of a chalky white amorphous mineral occurring in loose blocks was found on analysis to be  $CaCO_3.Mg(OH)_2$ . Its specific gravity is 2.412.

E.T.W.

THE SOLUBILITY OF THE LIME, MAGNESIA, AND POTASH IN SUCH MINERALS AS EPIDOTE, CHRYSOLITE, AND MUSCOVITE. R. F. GARDINER. *Bur. Soils, U. S. Dept. Agr. J. Agr. Research*, 16, 263-278, 1919.

Aqueous extracts of acid soils, on being mixed with these minerals and allowed to stand for two months, extracted up to nearly 2 per cent. of the bases.

E.T.W.

MARYLAND CHROME SAND ORE. JOSEPH T. SINGEWALD, JR. *Econ. Geol.*, 14, 189-197, 1919.

The origin and working of the deposits are described in detail. Analyses of fractions separated magnetically showed that if  $Cr_2O_3$  is in excess over  $Al_2O_3$ , it takes less than 30 per cent. of the magnetite molecule to make the resulting mineral highly magnetic. On the other hand, if  $Al_2O_3$  exceeds  $Cr_2O_3$ , the presence of even 26 per cent. of magnetite does not produce distinct magnetism. These relations should be taken into account in prospecting.

E.T.W.

MICROSCOPIC EXAMINATION OF CLAYS. R. E. SOMERS. Cornell Univ. *J. Wash. Acad. Sci.*, 9, 113-126, 1919.

An elaborate report on the results of study of over a hundred clays. Noteworthy minerals found to be present in some or in most of these are: kaolinite crystals, "hydromica," regarded as intermediate between sericite and kaolinite, rutile, zircon, tourmaline, epidote, titanite, diaspore, and halloysite. The disappearance of some of these on heating was also studied.

E.T.W.

MICRO METHODS FOR THE DETERMINATION OF CARBON DIOXIDE AND MOISTURE IN MINERALS. G. K. ALMSTRÖM. *Svensk Kem. Tidskrift*, 31, 71-74, 1919; thru *Chem. Abstr.* 13 (12), 1289, 1919.

The  $CO_2$  content of minerals could be accurately determined by fusion with  $K_2Cr_2O_7$  or with  $V_2O_5$ , but both gave too high results for  $H_2O$ . A micro-Penfield apparatus gave good results for  $H_2O$  determination with minute amounts of minerals.

E. T. W.